Homework Assignment 5: Due at the beginning of class 2/15/02

Figure 1: Unit insignia for VA-145 ("Swordsmen").

As you probably learned in the lab on Tuesday, landing a jet on an aircraft carrier is one of the most difficult jobs in military aviation. (According to studies carried out during the Vietnam war[1], navy pilots experienced more stress during carrier landings than during air combat.) In order to make landings a little easier, navy jets are equipped with arrester hooks ("tail hooks") that the pilot uses to catch wires on the carrier deck. Despite this, it is not uncommon for a naval aviator (i.e. navy pilot) to miss a landing and have to make several attempts at landing.

The probability that a pilot will land on a carrier is called the pilot's "boarding rate." For example a boarding rate of 0.9 means that a pilot will successfully land on 9 out of every 10 attempts. According to US Navy regulations[2], pilots must achieve a daytime[3] boarding rate of 0.75 in order to be qualified to operate from an aircraft carrier.

In 1992, the US Navy attack squadron VA-145 ("Swordsmen" see Figure 1[4]) were regarded as the best attack squadron in the Navy. This squadron flew the A-6E ("Intruder" see Figure 2[5]) attack bomber and were disbanded in 1993 when the US Navy decommissioned the A-6E. During 1992, VA-145 was awarded the COMNAVAIRPAC Battle "E," CNO Safety "S," Arleigh Burke Fleet Trophy

Figure 2: The Grumman A-6E "Intruder" attack bomber.

---

[1] Miller, R.G., Rubin, R.T., Clark, B.R., Crawford, W.R. and Arthur, R.J. (1970) "The stress of aircraft carrier landings: 1. Corticosteroid responses in naval aviators." *Psychosomatic Medicine*, **32**: 581-588.

[2] COMNAVAIRPAC Instruction 3740.2W and COMNAVAIRLANT Instruction 3740.120, Section 9 Paragraph (c).

[3] The US Navy also conducts carrier operations during night. According to US Navy regulations, a pilot must have a night boarding rate of 0.65 in order to be qualified to operate from an aircraft carrier.

[4] Image source: http://www.swordsmen.org/insignia.htm

[5] Image source: http://www.swordsmen.org/gallery-90.htm

and the RADM C. Wade McClusky Award as the Best Attack Squadron in the Navy. During this time, the pilots of VA-145 maintained a boarding rate of 0.98 (the best in their air wing[6]). Questions 1-5 refer to this information.

1. Assume that a pilot from VA-145 is attempting to land on an aircraft carrier. Use the information given above to calculate the probability that the pilot will land on his or her first attempt, second attempt, etc.

Attempt at landing	Probability that VA-145 pilot will land successfully on that attempt:
First	
Second	
Third	
Fourth	
Fifth	

NOTE: You should hand in a completed version of this table as part of your completed homework assignment.

2. Use the results that you calculated in Problem 1 to complete the table given below.

VA-145 Pilot lands successfully on:	Probability that this will happen
First attempt	
First or second attempt	
First, second or third attempt	
First, second, third or fourth attempt	
First, second, third, fourth or fifth attempt	

NOTE: You should hand in a completed version of this table as part of your completed homework assignment.

3.   Use geometric series to show that if the aircraft has enough fuel to make as many attempts as the pilot wants[7], then the probability that the pilot will eventually land is equal to one. That is, if there is sufficient fuel available, then it is absolutely certain that the pilot will eventually manage to land the aircraft.

HINT: Use geometric series to work out the probability that the pilot will be able to land sometime during n attempts at landing. Once you have a formula for this probability, calculate the limit of this formula is as $n \to \infty$.

The "expected value" is the sum of the possible values of the quantity times the probabilities of each possible value. For example, if you roll two dice then the "quantity" is the total of the two dice. The probabilities of different totals on two dice are given in the table below.

Total of two dice	2	3	4	5	6	7	8	9	10	11	12
Prob-ability	1/36	2/36	3/36	4/36	5/36	6/36	5/36	4/36	3/36	2/36	1/36

The "expected value" for the total of the two dice is given by the calculation:

Expected value   =   2*(1/36) + 3*(2/36) + 4*(3/36) + 5*(4/36) + 6*(5/36) + 7*(6/36) + 8*(5/36) + 9*(4/36) + 10*(3/36) + 11*(2/36) + 12*(1/36)

     =   7.

4.   Create a series that gives the expected value for the number of attempts at landing that a **minimally competent** carrier pilot will make when attempting to land during the day. (Note: There is no need for you to find the sum of the series - the idea here is just to write down sufficiently many terms so that the pattern is clearly established.)

5.   Is the series that you created in Question 4 a geometric series or not? Give some evidence to back up your conclusion.

---

[7] This is not a completely unreasonable assumption as an aircraft carrier conducting flight operations would normally have several tanker aircraft (the current model is the KA-6) hanging around in the general area. These tankers could refuel the minimally competent pilot's airplane while it was still in the air.